

GUST TUNNEL

The aircraft design process devotes considerable time to ensure that the airframe structure will be the lightest and most acceptable approach to meeting requirements based on in-flight and ground-induced structural loads. One traditional challenge has been the development and validation of technical methods to predict air loads experienced during flight in gusts and turbulence. This capability is extremely important, not only from a safety-of-flight perspective, but also to prevent an over design of aircraft structures which would result in unnecessarily large weight penalties. Early research in the 1920s and 1930s at the NACA Langley laboratory included theoretical studies of loads generated in specific gust fields, but flight data to substantiate the predictions were extremely difficult to obtain at that time. In order to experimentally investigate gust loads under controlled conditions, the NACA designed and constructed a pilot gust tunnel in 1937 within an area of the Langley Full-Scale Tunnel (Building 643) building outside the tunnel flow circuit. This pilot gust-tunnel facility operated in the NACA East Area for almost a decade.

The pilot gust-tunnel testing technique consisted of launching dynamically scaled, free-flight airplane models through gusts of known shapes and intensities. During the flight measurements were made of the accelerations and reactions of the models due to the gusts. The test facility consisted of a gust generator, a catapult for launching the models, and two screens used to decelerate and catch the airplane model at the end of the flight. The gust generator was a large squirrel-gauge blower which supplied air to an expanding rectangular channel discharging a current of air upward. The vertical jet of air was 6-ft wide and 8-ft long and its air speed was controlled by combinations of screen meshes designed to produce the desired gust shape. After the catapulted airplane model completed its flight through the vertical-gust field, it impacted a barrier of vertical rubber strands which decelerated the model. After deceleration, the model nose (shaped like a barbed hook) engaged a burlap screen which stopped the model and held it until the model was removed by the tunnel operator. The propelling catapult was powered by a dropping weight, and the maximum model flight speed was adjustable by changing the amount of weight. The facility was capable of testing scaled airplane models having wings of about 3-ft span at speeds up to about 50 mph.

The pilot gust tunnel produced very valuable information on gust loads as affected by primary aircraft design variables, and results from the facility were used to justify reducing the structural design criteria that had led to over design of wing structures for certain types of aircraft configurations.

In 1945 the pilot gust tunnel was replaced by a new Langley Gust Tunnel which was similar in operational concept, but capable of testing larger 6-ft-span models at speeds up to 100 mph. The facility was housed in a new building (Building 1218) in the Langley West Area. Tests conducted in the new gust tunnel covered a wide range of emerging aircraft geometries including swept-back wings, and studies were made of the effects of aircraft structural frequencies and gust-load alleviation concepts. Operations of the gust tunnel continued through the 1940s and into the 1950s until the introduction of high flying jet transport aircraft. Flight of jet transports at high altitudes minimized the potential for gust encounters and thereby reduced the demand for continued NACA research on the topic. In addition, the limited speed capability and relatively small models used in the gust tunnel were viewed as major shortcomings for future transport aircraft. With its operational mission no longer justified, the Langley Gust Tunnel was dismantled in 1965. In its last operational years, the facility had been used to test instrumentation at low speeds, and it was also used as a fundamental noise research facility. Building 1218 was later converted to a conference and meeting center and is still in existence today.